

Four Additional Species of *Sonorella* (Gastropoda: Pulmonata: Helminthoglyptidae) from Sonora, Mexico

by

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Abstract. Four new species of *Sonorella* from north-central and northeast Sonora, Mexico, are described, illustrated, and compared to the following related species: *S. magdalenensis* (Stearns, 1890), *S. franciscana* Pilsbry & Ferriss, 1919, *S. baboquivariensis depressa* Pilsbry & Ferriss, 1915, *S. mormonum mormonum* Pilsbry, 1948, *S. m. huasabasensis* Miller, 1967, and *S. perhirsuta* Miller, 1967. Two of them are from the Chihuahuan Desertscrub, another from the Madrean Evergreen Woodland, and the other from the Semidesert Grassland bioregions.

INTRODUCTION

MILLER (1967b, c) added four new records to the poorly known snail fauna of Sonora (only four species of *Sonorella* were known at the time). He suggested that the southern limit of the genus *Sonorella* in central Sonora was determined by the locality of *Sonorella perhirsuta* Miller, 1967. Later, BEQUAERT & MILLER (1973) listed the eight species found in Sonora by that time, and drew the limits of the distribution of the genus in the southwest United States and northwest Mexico. Much of northern Sonora still remained to be explored, and from 1973 to date six new species have been described (NARANJO & MILLER, 1986; NARANJO, 1988a, b). Continued exploration has resulted in the discovery of the four new species described below.

The following abbreviations are used: SBMNH, Santa Barbara Museum of Natural History; USNM, National Museum of Natural History, Smithsonian Institution; ANSP, Academy of Natural Sciences of Philadelphia; FMNH, Field Museum of Natural History; UTEP, University of Texas at El Paso; UNAM, Universidad Nacional Autonoma de Mexico Coleccion Malacologica; ENG, E. Naranjo-Garcia, and WBM, W. B. Miller.

METHODS

The reproductive systems were dissected out and preserved as whole mounts in accordance with the method of GREGG (1959; MILLER, 1967a, and Miller, personal communication) as follows. The specimen to be mounted consists

of the dissected reproductive system of the snail, which is attached to the base of a cork by means of a short, bent insect pin through a flap of tissue at the genital orifice. The specimen is immersed in a vial filled with haematoxylin (saturated solution), suspended from the cork, which is used to stopper the vial, for a period of about 9 min. It is then removed and immersed in a similar-sized vial filled with destaining solution (2% HCl in 70% ethanol) for 2-5 min, until the specimen has changed color from deep black to light purple. It is removed and placed in 70% ethanol for a period of 3-5 min, sufficient to dilute most of the absorbed acid. Finally it is placed in an eosin stain (saturated solution of eosin-Y in 70% ethanol), where it may remain indefinitely, until it can be mounted. Protracted immersion in the eosin solution, however, will cause hardening of the tissues prior to mounting. Normally, 1-2 min of immersion are adequate for eosin staining.

The specimen is removed from the eosin solution and placed on a slide (25 × 75 mm or 50 × 75 mm for large specimens). At this time, the structures can be cleaned of bits of attached connective tissue, and the organs separated and straightened (for subsequent measurements and comparative examination). A cover slip, or a similar slide, to which a very fine film of vaseline has been applied on the underside, is then placed on top of the specimen, and the slide, mount, and cover slip are tied firmly together with a piece of thread near each end to prevent the specimen from falling out during the dehydration and clearing processes. The vaseline is used to prevent sticking of the cover



Figure 1

A. *Sonorella torreonica* Naranjo-Garcia, sp. nov. Shell of paratypes and holotype (middle), SBMNH 34951. Umbilicus; aperture; apical view. B. *Sonorella sasabe* Naranjo-Garcia, sp. nov. Shell of paratypes and holotype (middle), SBMNH 34954. Umbilicus; aperture, apical view.

slip to the specimen when it is removed for embedding in Permunt® (histological mounting medium from Fisher Scientific).

The whole mount is dehydrated in a series of three jars of 100% ethanol. Since the dissection is usually done under 70% ethanol, the mount can be placed directly into 100% ethanol. The whole mount is immersed in each jar for a minimum of one day. This assures maximum removal of water from the tissues.

After the third immersion in 100% ethanol the whole mount is transferred to a jar filled with 50% toluene and 50% ethanol, where it is kept for a minimum of one day. It is then immersed in a series of four toluene-filled jars, a minimum of one day per jar, in order to assure that all of the ethanol has been removed from the tissues. This process also serves to clear the lipids from the tissues and allows the transparent viewing of internal structures.

After the fourth toluene immersion, the whole mount is placed on a flat surface, the cover slip is removed, and a

layer of Permunt is poured over the preparation. A clean cover slip, or slide, is placed on top, and care is taken to eliminate bubbles. The whole mount is then set aside to dry. The drying process may take several days and additional Permunt may need to be added, with a pipette, to compensate for evaporation during the drying process.

Permanent mounts are stored horizontally in covered, dust-free containers.

DESCRIPTIONS

Family HELMINTHOGLYPTIDAE Pilsbry, 1939

Genus *Sonorella* Pilsbry, 1939

Sonorella torreonica Naranjo-Garcia, sp. nov.

(Figures 1A, 2)

Description of shell of holotype (Figure 1A): Shell globose, heliciform, light tan, with dark brown spiral band

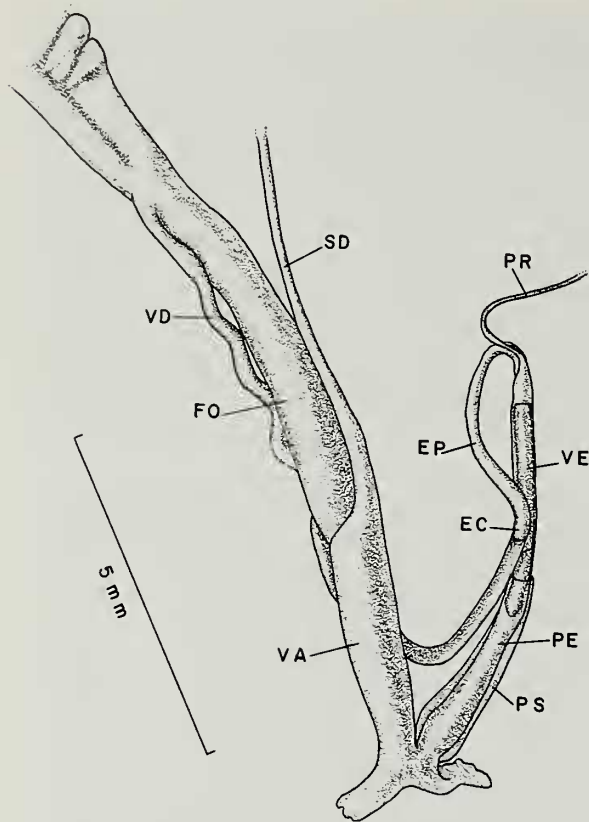


Figure 2

Sonorella torreonica sp. nov. Lower reproductive anatomy of holotype, SBMNH 34951. EC, epiphallal caecum; EP, epiphallus; FO, free oviduct; PE, penis; PR, retractor muscle; PS, penial sheath; SD, spermathecal duct; VA, vagina; VD, vas deferens; VE, verge.

on rounded shoulder. Narrowly umbilicate, umbilicus contained 10 times in diameter of shell, $\frac{1}{4}$ covered by reflected columellar lip. Embryonic shell of about $1\frac{1}{2}$ whorls. Apex with heavy wrinkles followed by spiral descending and ascending threads, and granules superimposed on finer wrinkles. Post-apical whorls with growth wrinkles and occasional weak punctae and granules. Body whorl somewhat silky in appearance, and with radial growth wrinkles descending just behind aperture. Aperture oblique, ovate-lunate, margins converging. Parietal callus thin. Lip slightly thicker than rest of shell. Shell measurements in mm: diameter 18.0; height 11.9; umbilicus 1.8; whorls 4.

Reproductive system (Figure 2): Apical structures characteristic of genus. Penis short, slender, increasing in diameter at junction with vagina, inner walls faintly glandular. Verge smooth, about $\frac{1}{2}$ length of penis, with conical tip. Penial sheath about $\frac{1}{2}$ length of penis. Lumen of epiphallus rather wide; inner walls glandular. Epiphallal caecum minuscule. Vagina stout, slightly shorter than penis; inner walls smooth. Measurements in mm: penis 5.2;

verge 3.0; penial sheath 2.7; vagina 3.2; epiphallal caecum 0.4.

Type locality: MEXICO, Sonora, Sierra el Torreón, 17 road miles (27 km) SE Magdalena on road to Cucurpe; $30^{\circ}27.8'N$, $110^{\circ}48.5'W$; elevation ca. 1050 m, under volcanic rocks.

Type material: Holotype: SBMNH 34951 (shell and dissected soft anatomy).

Paratypes: USNM 859326; ANSP 370245; FMNH 205938; UTEP 11105; UNAM 1211; ENG 469 and 535; WBM 7454 and 7512.

Etymology: This species is named after the mountain range in which it lives, Sierra el Torreón.

Remarks: The habitat corresponds to the Madrean Evergreen Woodland biotic community of BROWN (1982). Primary vegetation includes: *Cassia leptocarpa*, *Ceanothus huichugore*, *Cupressus arizonica*, *Dodonea viscosa*, *Erythrina flabelliformis*, *Garrya wrightii*, *Juniperus deppeana*, *J. monosperma*, *Mimosa biuncifera*, *Quercus oblongifolia*, *Rhamnus betulaeifolia*, *Rhus choriophylla*, *Rhus trilobata*, and *Tillandsia recurvata*.

Sonorella sasabe Naranjo-Garcia, sp. nov.

(Figures 1B, 3)

Description of shell of holotype (Figure 1B): Shell depressed-globose, heliciform, thin, glossy, light brown with a darker reddish-brown band on upper region of rounded shoulder. Umbilicus contained 7.7 times in diameter of shell. Embryonic shell of one whorl; apex of embryonic shell smooth with fine radial ripples, followed by fine reticulate sculpture, subsequently fine but strong descending striae on top of growth wrinkles. Sculpture almost disappears, on post-apical whorls only growth wrinkles and scattered, very fine rounded papillae remain. Body whorl only with growth wrinkles. Aperture ovate-lunate, wider than high, lips converging and basal lip slightly covering umbilicus. Shell measurements in mm: diameter 17.8; height 10.5; umbilicus 2.3; whorls 4.

Reproductive anatomy (Figure 3): Penis long, glandular, upper $\frac{1}{3}$ containing stout, almost cylindrical verge; verge thickening from apical region to center, sculptured with diagonal furrows not interconnected, conical tip; seminal duct terminal. Epiphallus about same length as penis, bearing small epiphallal caecum embedded in connective tissue. Penial sheath ca. $\frac{1}{3}$ length of penis. Vagina slightly longer than penis, inner wall glandular, cylindrical, slender at basal end, with very prominent and strong muscular collar on upper portion near apical end. Free oviduct glandular. Measurements in mm: penis 10.9; verge 4.4; penial sheath 3.5; vagina 11.9; free oviduct 3.2; epiphallus 11.0.

Type locality: MEXICO, Sonora, Sierra Pozo Verde, on E flank of Cerro El Sasabe, 4 km S of Sasabe on road to

Altar; 31°26.3'N, 111°33.8'W; elevation ca. 1050 m in igneous boulders.

Type material: Holotype: SBMNH 34954 (shell and dissected soft anatomy).

Paratypes: USNM 859325; ANSP 370244; FMNH 205939; UTEP 11104; UNAM 1212; ENG 473; WBM 7243 and 7447.

Etymology: This species is named after the nearby mountain (Cerro El Sasabe) and town, El Sasabe.

Remarks: The habitat corresponds to the Semidesert Grassland biotic community of BROWN (1982). The main vegetation includes: *Prosopis glandulosa*, *Acacia greggii*, *Fouquieria splendens*, *Carnegiea gigantea*, *Larrea tridentata*, and *Opuntia phaeacantha*.

Sonorella madreana Naranjo-Garcia, sp. nov.

(Figures 4A, 5)

Description of shell of holotype (Figure 4A): Shell depressed-globose, heliciform, thin, silky, light brown with narrow, chestnut spiral band on upper shoulder; shoulder rounded. Umbilicus narrow, approximately $\frac{1}{8}$ diameter of shell, slightly covered by reflected columellar lip. Embryonic shell of about $1\frac{1}{2}$ whorls, with radial ripples, rounded granules on ascending and descending threads, and roughened appearance; abruptly changing to rounded granules on strong radial wrinkles. Post-embryonic whorls with growth wrinkles. Aperture oblique, rounded, margins converging, peristome delicately expanded. Shell measurements in mm: diameter 17.8; height 10.9; umbilicus 2.3; whorls $4\frac{1}{2}$.

Reproductive system (Figure 5): Penis long, $\frac{2}{3}$ of upper inner walls glandular, containing long, smooth cylindrical verge, barely tapering to tip; seminal duct opening subterminally adjacent to diagonally pointed tip; verge about $\frac{1}{2}$ length of penis. Penial sheath enveloping about $\frac{1}{2}$ of penis. Epiphallus thin with detached, rather short epiphallic caecum. Vagina barely shorter than penis, wider at apical end, inner walls glandular. Measurements in mm: penis 9.4; verge 4.9; penial sheath 4.5; epiphallic caecum 1; vagina 7.1.

Type locality: MEXICO, Sonora, Sierra Las Minitas, ca. 2 km SE of Rancho Jucal buildings; 31°11.1'N, 109°4.7'W; elevation ca. 1400 m, in rhyolite rockslide.

Additional locality: MEXICO, Sonora, Sierra Las Minitas, along east bank of Rio Los Embudos, in rockpile ca. $\frac{1}{2}$ km E of Rancho El Jucal buildings; 31°11.8'N, 109°5.2'W; elevation ca. 1200 m.

Type material: Holotype: SBMNH 34952 (shell and dissected soft anatomy).

Paratypes: USNM 859327; ANSP 370243; FMNH 205936; UTEP 11103; UNAM 1214; ENG 403; WBM 7407.

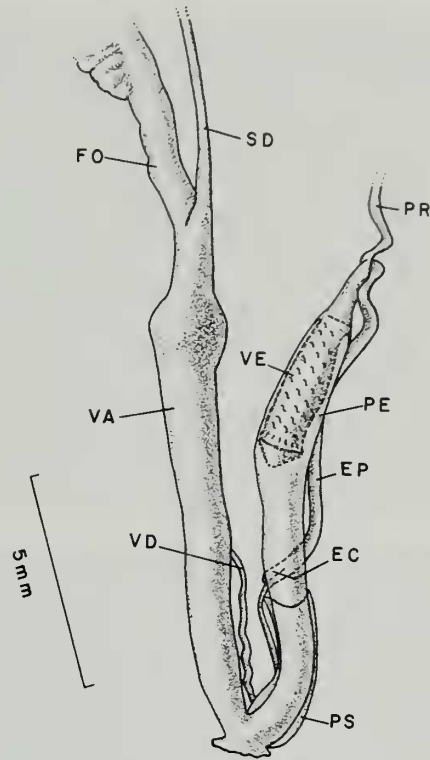


Figure 3

Sonorella sasabe sp. nov. Lower reproductive anatomy of holotype, SBMNH 34954. EC, epiphallic caecum; EP, epiphallus; FO, free oviduct; PE, penis; PR, penial retractor muscle; PS, penial sheath; SD, spermathecal duct; VA, vagina; VD, vas deferens; VE, verge.

Etymology: This species is named after the Sierra Madre Occidental, in which the Sierra Las Minitas is an outlier.

Sonorella walteri Naranjo-Garcia, sp. nov.

(Figures 4B, 6)

Description of shell of holotype (Figure 4B): Shell depressed-globose, heliciform, thin, shiny, tan, with darker brown spiral band on well rounded shoulder. Umbilicus rather wide contained about 6 times in diameter. Embryonic shell of about one whorl, with small smooth area on apex, followed by rounded granules on closely spaced radial wrinkles, and extremely subtle spiral descending striae on upper surface (worn smooth in live specimens); sculpture stronger near suture; succeeding whorls with granules on growth wrinkles, granules gradually disappearing to body whorl leaving only wrinkles. Body whorl descending steeply to scarcely expanded peristome. Aperture oblique, rounded, wider than high, margins converging, parietal callus thin. Measurements in mm: diameter 20.0; height 11.9; umbilicus 3.3; whorls 5.

Reproductive system (Figure 6): Penis long, enveloped by penial sheath for approximately $\frac{1}{4}$ – $\frac{1}{3}$ of its length.



Figure 4

A. *Sonorella madreana* Naranjo-Garcia, sp. nov. Shell of paratypes and holotype (middle), SBMNH 34952. Umbilicus; aperture; apical view. B. *Sonorella walteri* Naranjo-Garcia, sp. nov. Shell of paratypes and holotype (middle), SBMNH 34953. Umbilicus; aperture; apical view.

Verge long, cylindrical, smooth, with fine undulations, with central seminal duct and acute tip. Epiphallus shorter than penis, bearing distinct epiphallic caecum surrounded by connective tissue. Vagina longer than penis, cylindrical. Free oviduct almost $\frac{1}{2}$ length of vagina. Measurements in mm: penis 8.4; verge 3.6; penial sheath 2.8; epiphallus 5.6; epiphallic caecum 1.9; vagina 10.0; free oviduct 4.5.

Type locality: MEXICO, Sonora, Cerro Gallardo, ca. 1.5 km S of Rancho Gallardo buildings; 31°17.8'N, 109°23.4'W; elevation ca. 1500 m; in N facing rhyolite rockpiles below cliffs.

Type material: Holotype: SBMNH 34953 (shell and dissected soft anatomy).

Paratypes: USNM 859324; ANSP 370246; FMNH 205937; UTEP 11106; UNAM 1213; ENG 537; WBM 7424.

Etymology: This species is named for Walter B. Miller, who has greatly contributed to the knowledge of the land snail fauna of the Southwest.

Remarks: The latter two species described are found in the Chihuahuan Desertscrub biotic community of BROWN (1982), which is defined by the following plants: *Larrea tridentata*, *Prosopis glandulosa* var. *torreyana*, *Acacia greggii*, *Coldenia canescens*, *Dasylyrion leiophyllum*, *Fouquieria splendens*, *Jatropha dioica*, *Juniperus monosperma*, *Krameria parvifolia* var. *glandulosa*, and *Rhus microphylla*.

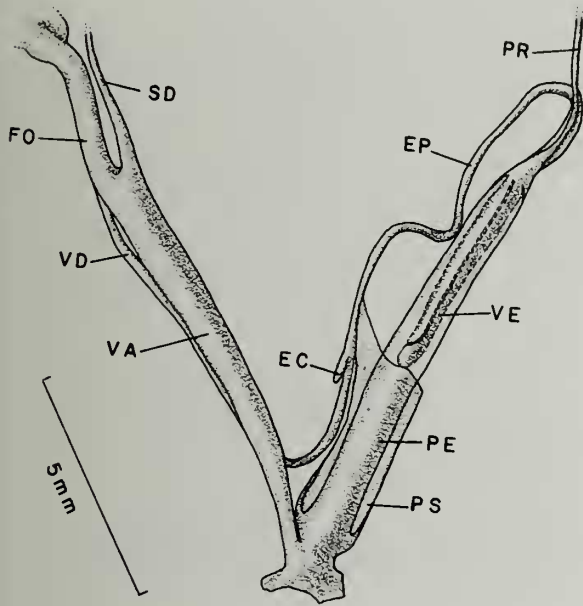


Figure 5

Sonorella madreana sp. nov. Lower reproductive anatomy of holotype, SBMNH 34952. EC, epiphallic caecum; EP, epiphallus; FO, free oviduct; PE, penis; PR, penial retractor muscle; PS, penial sheath; SD, spermathecal duct; VA, vagina; VD, vas deferens; VE, verge.

DISCUSSION

Sonorella torreonica appears to be related to *S. mormonum mormonum* Pilsbry, 1948, and *S. mormonum huasabasensis* Miller, 1967, because these three taxa share short and slender basal reproductive structures. *Sonorella torreonica* differs by having a shorter vagina and penis and by lacking the glandular inner walls present in the two *S. mormonum* subspecies. The verge in *S. m. mormonum* is thicker and rounded at the tip, and has a depressed conical dimple, whereas in *S. torreonica* the verge is cylindrical, slender, and has a conical, pointed tip. In *S. m. huasabasensis* the verge is rather cylindrical, somewhat thicker at mid length and tapering finely to a blunt tip. In addition in both *S. mormonum* subspecies the verge is $\frac{1}{3}$ to almost $\frac{1}{2}$ the length of the penis, whereas in *S. torreonica* the verge is $\frac{2}{3}$ this length. In *S. torreonica* and *S. m. huasabasensis* the vagina is about the length of the penis, whereas in *S. m. mormonum* the penis is longer than the vagina.

Sonorella sasabe resembles *S. magdalenensis* (Stearns, 1890). However, they differ in the fat, blunt verge of *S. sasabe* and the longer vagina and free oviduct of *S. magdalenensis*. The vagina is about $\frac{1}{3}$ longer than the penis in *S. magdalenensis*, while in *S. sasabe* they are about the same length. Additionally, *S. sasabe* possesses a strong vaginal collar located in the vicinity of the apical end of the vagina, while in *S. magdalenensis* the vaginal collar is

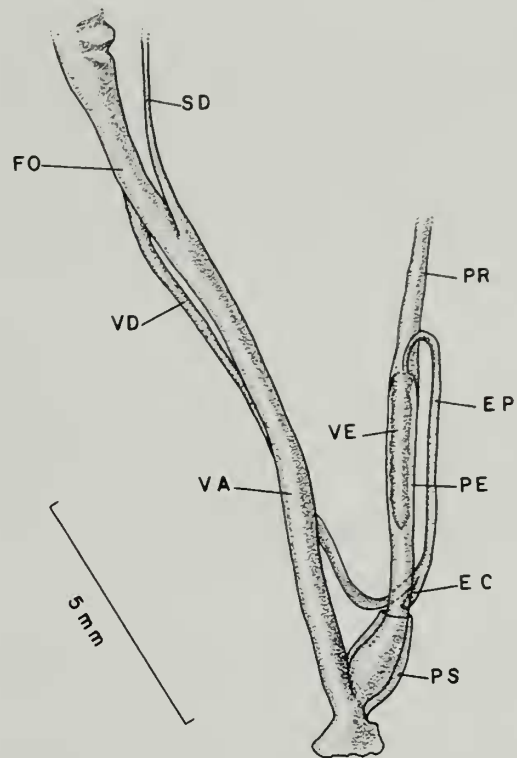


Figure 6

Sonorella walteri sp. nov. Lower reproductive anatomy of holotype, SBMNH 34953. EC, epiphallic caecum; EP, epiphallus; FO, free oviduct; PE, penis; PR, penial retractor muscle; PS, penial sheath; SD, spermathecal duct; VA, vagina; VD, vas deferens; VE, verge.

much smaller and located about halfway along the length of the vagina.

Sonorella madreana resembles *S. perhirsuta* Miller, 1967, but strong differences separate these species, the main one being the persistently hairy shell of *S. perhirsuta*. In both species the length of the vagina and the penis are approximately the same. In *S. madreana* the seminal duct opening is consistently subterminal, opening in proximity to the basal end of the verge, whereas in *S. perhirsuta* it opens more apically about $\frac{2}{3}$ – $\frac{3}{4}$ of the way along the length of the verge (MILLER, 1967b). The verge in both species is long and full, with a blunt diagonal tip, although less defined in *S. perhirsuta*. *Sonorella perhirsuta* has an ample cylindrical vagina along its entire length, whereas *S. madreana* has a slender cylinder diminishing in diameter to the gonopore.

The reproductive anatomy of *Sonorella walteri* is somewhat similar to that of *S. franciscana* Pilsbry & Ferriss, 1919, and *S. baboquivariensis depressa* Pilsbry & Ferriss, 1915. Differences exist, however, in specific measurements of the principal structures as follows: the verge has a blunt tip and is greater than $\frac{1}{2}$ the length of the penis in *S.*

franciscana; in *S. walteri* the verge has an acute tip and is shorter than $\frac{1}{2}$ the length of the penis; the verge has a blunt tip and is only $\frac{1}{3}$ the length of the penis in *S. b. depressa*. The penis is $\frac{1}{2}$ the length of the vagina in *S. franciscana*, $\frac{2}{3}$ the length of the vagina in *S. walteri*, and equal to the length of the vagina in *S. b. depressa*. In view of the fact that *S. walteri* is geographically separated from both *S. franciscana* and *S. b. depressa* by over 240 km, with no intervening intergrading populations, these anatomical similarities are considered to result from convergence.

ACKNOWLEDGMENTS

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